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## Effect of dietary intake on serum calcium levels and bone mineral density of menopausal women of Ludhiana city, India

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### Abstract

Sixty women of 45-55 years, belonging to middle income group were selected on basis of their Bone Mineral Density (BMD) from a – “Clinic After Forty” of Ludhiana city, Punjab. Serum calcium and BMD were tested using techniques called o-Cresolphthalein complexone (oCPC) method and Dual energy X-ray Absorptiometry (DEXA) respectively. Subjects were given nutrition counseling (NC) twice a month for a period of 4 months. Assessment of nutritional status was done by dietary survey and anthropometric parameters before and after study. Dietary survey revealed that daily intake of milk and milk products ( $p < 0.05$ ), roots and tubers ( $p < 0.01$ ), green leafy vegetables (GLVs) ( $p < 0.01$ ), other vegetables and fruits ( $p < 0.01$ ) increased significantly whereas intake of sugar and jaggery and fats and oils ( $p < 0.01$ ) decreased significantly after NC. Intake of beta carotene, vitamin C, iron, calcium and phosphorus also increased significantly. Mean weight, Body Mass Index (BMI) waist-circumference, hip circumference and WHR decreased significantly after NC. Biochemical assessment revealed significant improvement in serum calcium levels and BMD from 7.82mg/dl to 8.99mg/dl ( $p < 0.01$ ) and -2.2 to -2.01 ( $p < 0.01$ ) respectively. Subjects were classified as osteopenic and osteoporotic on basis of their t-scores. Majority of the subjects were osteopenic and the rest were osteoporotic. But after NC %age of osteopenic subjects increased while %age of osteoporotic subjects decreased. Study emphasized the importance of NC to bring about positive changes in dietary intake of menopausal women which in turn improved their serum calcium levels and BMD. Hence NC can be taken as an effective and sustainable tool to tackle osteoporosis as it is a serious public health issue among Indian menopausal women.

**Keywords:** Bone Mineral Density, Menopausal women, Osteoporosis, Serum Calcium

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## INTRODUCTION

Osteoporosis or porous bone disease is a disease characterized by a low bone mass and structural deterioration of bone tissues leading to bone fragility and an increased susceptibility to fractures of hip, spine and wrist. It is a disease in which both the quantity and quality of bones are reduced. Quantity is measured from Bone Mineral Density BMD. Quality is affected by many factors including the degree of mineralization, connectivity of the bony trabeculae, the quality of the collagen fibres, and the health of the bone cells. During childhood, the bone formation occurs at fastest rate and the bone resorption is very slow. After attaining maximum height, still bone formation continues at faster pace than resorption until around early twenties (peak bone mass attainment). In the later twenties, bone mass remains

stable or decreases very gradually depending on the lifestyle factors. After that, during middle age, the bone mass starts to decline rapidly in women during menopausal stage (Chowdhary, 2012). Menopause is a reproductive milestone in a woman's life. This process doesn't arrive suddenly, it takes around 3-4 years beginning with perimenopause, when body starts running out of eggs, ovulation becomes sporadic, hormone levels fluctuate and cycle becomes unpredictable. It brings a woman acutely face to face with reality of ageing when menstrual activity decreases and eventually ceases and body decreases production of female hormones-estrogen and progesterone. The term comes from the Greek words- 'Mena' and 'Paus' meaning 'Month' and 'Pause'. The menopause accelerates age related bone loss (Susan, 2001) Post menopausal osteoporosis is a very common problem characterized by low bone mass micro

architectural deterioration of bone tissue leading to enhanced bone fragility and consequently increasing the fracture risk among elderly people (Dempster and Lindsay 1993). However, osteoporosis is the sub-clinical or symptomless condition and becomes clinically evident only when a person suffers a fracture. Besides the uncontrollable factors such as age, sex and menopause, several controllable factors such as multiparity, physical activity, nutritional status and drugs affect osteoporosis. (Deepti *et al* 2006). It is basically classified into two major categories, osteoporosis I and Osteoporosis II. The type I occur in women within few years of menopause because of cessation of ovarian production of estrogen. It is also known as post menopausal osteoporosis. Type II is also called the age associated osteoporosis and it is not linked to the female gender (Chowdhary 2012).

The intake of calcium and protein rich foods during childhood and adolescence is an important contributor to peak bone mass. They are also crucial for maintenance of bone mass and prevention of bone loss in adults. As women go through menopause their metabolism slows down, their vitamin requirements increase but calorie requirements decrease. So the modification in the diet intake becomes imperative keeping in mind the physiological state in which these women are with decline in production of estrogen in body. Complex carbohydrates should be preferred to simple carbohydrates as they are digested more slowly than simple carbohydrates, which enter blood stream directly from digestive tract. Intake of coffee, caffeine products and carbonated drinks should also be restricted as they increase urinary loss of calcium and decrease bone mass. The importance of nutrition intervention is paramount. Nutrition education aims at importance of balanced diet and healthy eating habits for improvement and management of health and nutritional status thus reducing potential complications, promoting physiological and psychological well being and encouraging healthy eating habits in menopausal women. Hence a well balanced diet along with stress management and routine exercise help women in better management of menopausal problems and associated complications. (Prasad 2010). So, the objective of the investigation was to find out impact of dietary intake on serum calcium lever bone mineral density of menopausal women.

## MATERIALS AND METHODS

The study was conducted in Iqbal Nursing Home of Ludhiana city, India as a "Clinic After Forty" is being run for the women there. A sample of 60 post-menopausal women between the age-group of 45-55 years belonging to middle income group were selected on the basis of their BMD which was tested using a technique known as Dual En-

ergy X-ray Absorptiometry (DEXA). Those having low BMD were included in the study.

Interview-cum-questionnaire method was used for collecting general information of the subjects. Information regarding their age, occupation, marital status, family type, educational level, occupation and educational level of spouse, family and per capita income was recorded. The assessment of nutritional status of the subjects was done by dietary survey, anthropometric measurements and biochemical investigation of blood before and after NC for a period of four months. The dietary survey was conducted for 3 consecutive days using 24 hours recall method. For calculating daily nutrient intake of macronutrients and micronutrients of each subject, 'MSU nutriguide software' developed by Song *et al* (1992) was used. The adequacy of nutrients was assessed by comparing the nutrient intake with Recommended Dietary Allowances (RDA) of ICMR (2011). Anthropometric measurements of height, body weight, waist circumference, and hip circumference of the subjects were recorded before and after NC using standard methods (Jelliffe, 1966). Serum calcium was analyzed by oCPC method (Gitelman, 1967) and Dual Energy X-Ray Absorptiometry (DEXA) was used for measuring Bone Mineral Density of the subjects, two times, one at the beginning of the survey and second after four months of experimentation. DEXA was performed by the laboratory technicians with the Pronosco X-Posure System. The Principle for DEXA is: X- Rays are used to produce images of spine, hip, forearm or even the whole body. X-rays are composed of two energy levels which are absorbed differently by the bones in the body. A computer is able to determine from these differences how much bone mineral is present. The spine, hip and forearm are measured because that is where osteoporotic fractures occur the most.

Nutrition education was imparted to the subjects twice a month, for a period of four months. On the basis of their dietary pattern they were given knowledge about the sources of calcium and how to include those in their daily diet. A sub-sample consisting of 30 respondents having serum calcium levels less than 9mg/dl were selected. The effect of dietary calcium intake after four months was seen by analyzing their serum calcium. The data collected was statistically analyzed using mean, standard error, student's t-test and Karl Pearson's coefficient of correlation (r) using Microsoft Excel (2010) statistical analysis tool pack.

## RESULTS AND DISCUSSION

Data revealed that the mean age of the respondents was 49.5 years with majority between the age-group of 45-55 years, whereas Singh (2012) found that average age of menopause in Hyderabad women was 46 years which was lower than

**Table 1.** General Information of the post menopausal women of Ludhiana City.

Parameter	No. of respondents (n=60)	(%)
<b>Age (Years)</b>		
45-50	38	63.33
51-55	22	36.67
<b>Educational level of the respondents</b>		
Under Graduate	9	15
Graduate	41	68.33
Post-graduate	10	16.67
<b>Educational level of the spouses of the respondents</b>		
Under Graduate	8	13.33
Graduate	35	58.33
Post-graduate	15	25
<b>Marital Status</b>		
Unmarried	2	3.33
Married	58	96.67
<b>Family type</b>		
Nuclear	44	73.33
Joint	7	11.67
Extended	9	15
<b>Occupation of the respondents</b>		
House wife	40	66.67
Service	18	30.00
Business	2	3.33
<b>Occupation of the spouses of respondents</b>		
Service	27	45
Business	31	51.67
<b>Family Income (Rs.)</b>		
10000-20000	44	73.33
20001-30000	16	26.67
<b>Per Capital Income (Rs.)</b>		
<4500	34	56.67
4501-6500	18	30
>6500	8	13.33

**Table 2.** Change in the % adequacy of food intake after NC (n = 60).

Food Group	Before	After (4 months)	Suggested Intake <sup>1</sup> g/day
Cereals	82.33	88.77	300
Pulses	72.17	71.17	60
Milk and Milk Products	83.2	98.33	300
Roots and Tubers	57.6	81.3	100
GLV	18.8	49.32	100
Other Vegetables	34.47	58.9	100
Fruits	53.1	101.5	100
Sugar and Jaggery	104.5	86	20
Fats and Oils	151	92.5	20

<sup>1</sup>ICMR (2011)

the present study. According to Ceylan and Ozerdogan (2015), age of menopause could be attributed to a number of factors like mother's age at menopause, age at menarche, gestational age, use of oral contraceptives, irregular menstrual cycle, number of pregnancies, BMI, use of tobacco and alcohol and physical activity. Most of the women were married and belonged to nuclear families, having family members upto four. Most of the subjects, that is, 73.33 % had monthly family income in the range of Rs. 10,000 to Rs. 20,000. Mean per capita monthly income of the subjects was Rs. 4915. The subjects and their spouses were well-educated, that is, 68.33 % of the subjects were graduates. Whereas 58.33 % of the

spouses of the subjects were graduates. Majority of the respondents (66.67 %) were housewives. Forty five % spouses of respondents were in service and 51.67 % were in business.

The mean height of the respondents was 156.8 cm. The mean body weight decreased significantly ( $P<0.01$ ) from 72.03 to 69.97 kg which resulted in decrease of BMI from 29.53 to 28.68 kg/m<sup>2</sup>.

Nutrition education resulted in significant changes in food intake of the post menopausal women. The intake of milk and milk products increased significantly ( $P<0.05$ ) from 250 to 295g. The intake of roots and tubers, (58 to 81g), GLVs (19 to 49g), other vegetables (34 to 59g) and fruits (53 to 102g) increased significantly ( $P<0.01$ ) whereas the in-

**Table 3.** Average daily nutrient intake by the post menopausal women of Ludhiana City before and after NC.

Food Group	Before	After (4 months)	t- value	RDA <sup>1</sup>
Energy (Kcal)	2244.42±22.1	2132.33±13.38	4.58*	1700
Protein (g)	48.18±1.08	49.05±2.34	-0.36	50
Total Fat (g)	125.12±5.12	74.12±2.46	8.89*	40
b-carotene (mcg)	880.02±80.43	1183±52.07	-3.55*	2400
Thiamine (mg)	1.26±0.26	1.883±0.07	1.42	1.0
Riboflavin (mg)	1.14±0.06	1.11±0.07	0.32	1.1
Niacin (mg)	5.12±0.98	22.2±1.10	-6.44*	12
Vitamin C (mg)	85.92±11.62	98.92±9.8	-2.47**	40
Iron (mg)	16.73±0.99	21.92±0.99	-3.67*	30
Calcm (mg)	618.28±24.16	967.93±33.85	-8.12*	900
Phosphorus (mg)	861.58±36.99	1088.32±54.76	2.49**	1000

\* Significant at 1%, \*\* Significant at 5%, <sup>1</sup>ICMR (2011)

**Table 4.** Serum calcium and bone mineral density of the post menopausal women of Ludhiana city.

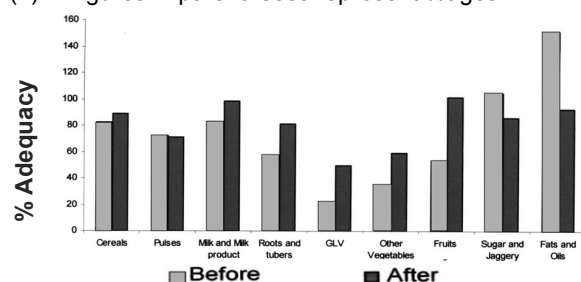
	Before	After (4 months)	t-value
Serum Ca (mg/dl) (n=30)	7.82±0.11	8.99±0.16	-6.48*
BMD (T-score) (n=60)	-2.2±0.11	-2.01±0.01	-2.48**

\* Significant at 1%, \*\* Significant at 5%

**Table 5.** Classification of subjects according to T-scores.

Diagnosis	T-score	(n=60)	
		Before	After (4 months)
Osteopenia	-1 to -2.5	40 (66.67)	48 (80)
Osteoporosis	<-2.5	20 (33.33)	12 (20)

( ) = Figures in parentheses represent %ages.

**Fig. 1.** Change in percent adequacy of food intake after ( Four Months)

take of sugar and visible fats and oils decreased significantly ( $P<0.01$ ) from 21 to 17g and 30 to 18g respectively in the respondents. Subsequently, there was a significant decrease ( $P<0.01$ ) in the intake of energy from 2244 to 2132 kcal. Overall energy intake by Punjabi post menopausal women as recorded by Kushwaha (2011) in Punjab was 1975 kcal which is lower than the present intake. Hence the % energy contribution from carbohydrates increased from 48 to 52 % and from fats decreased from 43 to 37 % which was still higher than the recommendations of 20 % energy from fats / oils (ICMR 2011). There was significant increase in the intake of carotene, vitamin C, iron, calcium and phosphorus after N.C. However, the intake of proteins, b-carotene and iron was still less than the RDAs.

The biochemical assessment of the subjects revealed that the serum calcium level of subjects improved significantly ( $P<0.01$ ) from 7.82 to 8.99 mg/dl but was still less than the standard range of

9-11mg/dl. The t-score of the BMD value increased significantly ( $P<0.02$ ) from -2.2 to -2.01 in subjects. The subjects were classified as osteopenics and osteoporotic on the basis of their t-scores. Majority (66.67 %) of the subjects were osteopenic and rest (33.33 %) of the subjects were osteoporotic. But after NC, the %age of osteopenic subjects further increased to 80 % and the percentage of osteoporotic subjects decreased to 20 %.

Thus, as the dietary intake of fats and oils and sugar and jaggery decreased and the intake of fruits, GLVs, other vegetables and milk products increased, lead to decreased intake of energy and total fat and significant increase in niacin, vitamin C, calcium, phosphorus and iron. This eventually lead to an in serum calcium levels and BMD.

## Conclusion

It was concluded that with better nutrition, especially intake of calcium rich foods, appropriate physical activities and exposure to sunlight for vitamin D synthesis in skin would also be valuable. NC imparted to menopausal women significantly decreased the intake of fats and oils and sugar and jaggery ( $p<0.01$ ) but increased the intake of fruits, GLVs, other vegetables ( $p<0.01$ ) and milk and milk products ( $p<0.05$ ). Hence the intake of energy and total fat reduced which helped decrease their BMI from 29.52 to 28.68kg/m<sup>2</sup> ( $p<0.01$ ). A significant improvement in serum calcium levels from 7.82 to 8.99mg/dl was seen ( $p<0.01$ ). The t-score of BMD value also increased

from -2.2 to -2.01 which was significant at 5 % level of significance. Not only school children and adolescents should be targeted for providing nutrition education but their parents and teachers can also be sensitized regarding the role of calcium rich foods for optimal development of peak bone mass. On the other hand, pregnant and lactating mothers and older individuals also need to be educated in order to reduce age related bone loss.

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